Soil Sampling and Soil Characterization Probes

The Challenge

More than half of the 149 single-shell tanks (SSTs) in the Hanford Site tank farms have been declared "assumed leakers." The vadose zone and soils around the SSTs are known to contain contaminants that have leaked from the tanks and entered the soil column. More up-to-date and extensive data is required to accurately determine the location and extent of existing leakage. The above ground and subsurface layout of the tank farms is not conducive to ideal placement of soil investigation tools such as boreholes. Budget and logistical constraints also limit the number of wells that can be constructed. An efficient, lower-cost and less-intrusive method for soil investigation is needed to support ongoing and future retrieval and site cleanup decisions.

Cone penetrometer platform in position at the Hanford 200 East Area site during demonstration testing. The inset shows the soil sampler components (main pipe (top) and canister (bottom).

Current Approach

Subsurface contamination in the soils surrounding the SSTs is currently monitored by lowering instruments into existing steel-cased boreholes. The boreholes are spaced around the tanks and extend to varying depths. Gamma detectors are lowered into the boreholes and respond to contamination within a 12-18" radius of the center of the borehole. Leak detection and monitoring effectiveness depends on whether the contamination moves within range of the gamma detectors. Instrument readings from the boreholes are reviewed to determine change in the depth and extent of contamination in the vicinity of the borehole. Data from one borehole to another is extrapolated to produce an approximation of potential leak plume shape and volume. Actual soil sampling cannot be conducted with the existing boreholes. Soil sampling can only occur during the placement of the wells. When wells are drilled with the specific purpose of obtaining soil samples, they are expensive, produce a large amount of soil waste, are located based upon modeling assumptions using past data, and are constrained from moving to many positions/locations around the tank or where data is needed. Most of the existing boreholes were installed prior to 1980. Very few new boreholes or wells have been prepared since, primarily because of regulatory/permitting requirements and funding constraints.

New Technology

Small diameter (less than 2 inches) probes, which use a cone penetrometer (CP) as a delivery system and can be hydraulically pushed into the soil, contain a variety of characterization/detection instruments including gamma and X-Ray fluorescence (XRF) detectors, soil sampling and soil moisture sensors, and Raman spectroscopy instruments. These instrumented probes can be used to "screen" the soil and vadose zone and locate regions of interest for follow on sampling. A soil sampling probe can then be deployed to a specific targeted depth to retrieve soil samples at only those points of interest. Removal of the CP probes produces a small diameter

Benefits and Features

- Cheaper soil and vadose zone waste screening
- Multiple number of different sensors can be used with the cone penetrometer
- Cone Pen can reach depths up to 170 feet in Hanford soils

hole that can be closed using grout. Push-depths as far as 170 feet have been achieved in Hanford soils. Such depths are adequate to provide the information of plumes that are believed to be within and around the base of the tanks. Achieved depths are dependent on soil composition and the push capabilities of the CP deployment vehicle.

Demonstration Description

Applied Research Associates, Inc. (ARA) of South Royalton, Vermont, under contract to the Hanford Tanks Initiative project, demonstrated the use of a multi-sensor probe (MSP) and a multi-sample soil sampling probe (SSP) at two Hanford locations. A CP probe preparation goal and DOE project milestone were met during the last quarter of FY 1998 when the complete CP system was first operated as a system to obtain data during a trial push in the 200 East Area. The activity marked the beginning of the Hanford Site cold push activities for performance evaluation and qualification testing. The demonstration push involved the positioning of the CP at the Immobilized Low Activity Waste Disposal Complex (ILAWDC), pushing of the multisensor probe with the data acquisition system operating, and the gathering of signals from the MSP instruments during the push event. During the weeks that followed the initial developmental push, additional push events were conducted on the probes (MSP and SSP) to further evaluate performance parameters and to set the stage for final probe qualification testing. The MSP included an X-Ray fluorescence detector, a gamma detector, and a soil moisture sensor.

Demonstration Results

The MSP was successfully demonstrated as a complete system to a depth of 25 feet. The MSP gamma spectroscopy instrument provided a resolution of 7.5 percent, which is one percent lower than that required by the probe preparation specification. Testing of the gamma module indicated that the minimum detection limit for Cesium-137 is 11.5 pCi/gm in Hanford soils. The MSP probe was also used to determine the soil stratigraphy and volumetric moisture content of the soils that were penetrated. These results were compared with other characterization information in the historical records for the test site and found to be consistent with earlier findings.

Prior to the field testing, the soil sampler (SSP) down-hole latching mechanism had been completely redesigned to provide greater reliability and a more robust lock-up. The final SSP design and the test deployment, represent a first for the CP industry.

Successful completion of the initial developmental push provided sufficient positive results to warrant continuing with the entire developmental testing program (and ultimately the qualitative testing). The push event also represented the first complete fielding event of the CP in conjunction with a specialized probe system.

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